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COTTON ANTHRACNOSE AND HOW TO CONTROL IT.

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INTRODUCTION.

Cotton anthracnose, quite commonly called boll-rot, is a serious enemy to the cotton crop, largely because of the fact that methods of control are not generally known. This bulletin describes the disease and sets forth the most effective means of reducing the damage from it.

The disease was first described by Atkinson and Southworth in 1891. At that time its distribution and prevalence were not well known, though it had been reported from several States.

Within the past few years the disease has been studied by several pathologists, and it is now known to occur annually to a greater or less degree throughout the cotton-growing sections of the country. It has been reported from all parts of Mississippi, including the different soil types found in the Delta and bottom lands, where it is the worst, as well as in the sand-hill and prairie regions of the State. It occurs in every county in South Carolina and appears to be on the increase. The disease is reported as present in every cotton field in the State of Georgia. Specimens of the trouble are received each year from all parts of the cotton belt, and, though some sections appear to be less affected than others, its occurrence is very general.

FIG. 1.—Early stage of cotton boll-rot, showing the small, dark, sunken spots; also two spots with pink spore masses in the center.

DESCRIPTION OF THE DISEASE.

Anthracnose attacks the cotton bolls, the young seedlings, the stems, and the boll pedicels.

BOLL-ROT.

The boll injury, commonly called boll-rot, is the most apparent and probably the most serious form of the disease. Minute round spots of a dull reddish color are the first visible indications of the trouble. (Fig. 1.) As they enlarge, the center at first becomes black, but later, if weather conditions are favorable, anthracnose spores are produced in abundance, beginning at the center, and the spots then take on the characteristic pink color, surrounded by a narrow border of dull red, which shades off to the normal green of healthy tissue. (Fig. 2.) In very dry weather the spores are produced sparingly and the spots are gray to black instead of pink. The spots enlarge to a half inch or more in diameter and where several coalesce irregular diseased areas are formed, which sometimes involve the entire boll. If the bolls are attacked when very young, they may be killed or the affected side dwarfed, while the other side continues nearly normal growth, resulting in the production of a one-sided boll which opens incompletely. When the disease attacks partly matured bolls, two or more locks often stick together and fail to open. In still other cases only a small diseased spot is visible externally, but the whole or a large part of the interior of the boll is decayed and little or no cotton is produced. (Fig. 3.) Any lock that is affected, however slightly, produces discolored cotton which

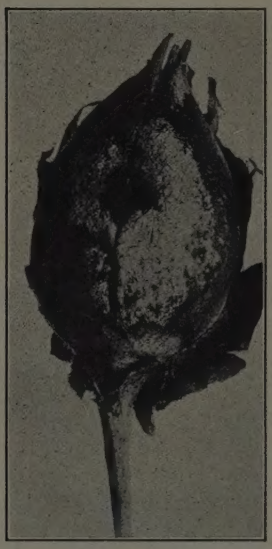

FIG. 2.—A boll of Sea Island cotton badly diseased with anthracnose and covered with a mass of pink spores.

FIG. 3.—A diseased cotton boll, showing only a small spot on the outside, yet the entire lock is decayed by anthracnose.

sticks to the bur; the lint is weak and worthless and lowers the grade of the whole picking, while the seed from every such lock will either

be destroyed or penetrated by the disease, so that it will act as a source of infection to the succeeding crop should it be used for planting. The interiors of badly diseased bolls decay and become inhabited by insects, which are in many cases considered by farmers to be the cause of the rot.

Another boll-rot caused by bacteria (*Bacterium malvacearum*) can be distinguished from typical anthracnose by the following differences: In the early stages the diseased spots are merely water soaked and greenish and have no border line of red; later, the central portions turn black, shrink, and dry up, but do not become pink unless also infected with anthracnose. The bacterial boll-rot usually spreads more rapidly than anthracnose and frequently involves the entire boll, causing it to turn black and to fail to open. The trouble almost always attacks the leaves as well, causing the disease known as angular leaf-spot, due to the production of angular, water-soaked, diseased areas on the leaves.

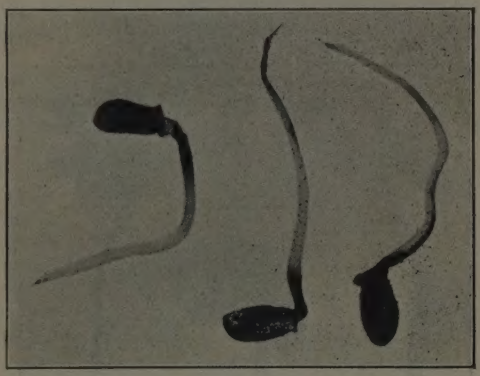

FIG. 4.—Seed from anthracnose-diseased cotton bolls sterilized externally and germinated in sterile Petri dishes. The fungus grew out from underneath the seed coats and attacked the sprouts at the black areas.

SEEDLING INJURY.

Anthracnose also attacks the young seedlings, killing the sprouts of badly infected seed before they appear above the ground or causing a damping-off near the soil of plants 2 to 4 inches high during periods of cold weather unfavorable to the growth of cotton. (Figs. 4 and 5.) In still other cases the seed leaves may be injured. Many broken stands are undoubtedly due in part to anthracnose killing the seedlings from infected cotton seed.

Damping-off due to anthracnose must be distinguished from "sore-shin" caused by the attacks of Rhizoctonia. The former attacks the seedlings at or just below the surface of the soil, causing them to wither and die much as if they had damped-off. The tissue reddens and shrinks, frequently in longitudinal lines. "Sore-shin" causes well-defined ulcers or diseased depressions of a brownish color on the stems of seedlings just below the surface of the soil. These are frequently outgrown, unless they have penetrated too deep into the interior tissues.

STEM INJURY.

Anthracnose sometimes attacks and kills the pedicels of bolls and causes the bolls to dry up and drop off. The disease on the stems of the cotton plant produces elongated areas which are at first dull red,

then black, and finally take on a pink color when the spores are produced. Affected branches are thereby weakened and are often broken during windstorms. Injury of this sort is sometimes associated with the presence of the bacterial disease known as black-arm, the anthracnose being secondary and accentuating the injury caused by the former.

CAUSE OF ANTHRACNOSE.

Anthracnose is caused by the attacks of the fungus *Glomerella gossypii*. This fungus is a moldlike plant growth of microscopic size, which penetrates the boll, seed, or seedling with its threadlike branches and causes the death of affected tissues. Two kinds of spores, microscopic seedlike bodies, are produced. The conidia are produced by the millions in sticky masses on the diseased seedlings, stems, or bolls and form the pink covering so characteristic of the disease. (Fig. 6.) The perfect or ascospore stage of the fungus has been found by Edgerton (figs. 7 and 8) on immature diseased bolls in Louisiana. Shear and Wood have also reported finding it in pure culture. No other report of the occurrence of the perfect stage either in culture or in nature has been made.

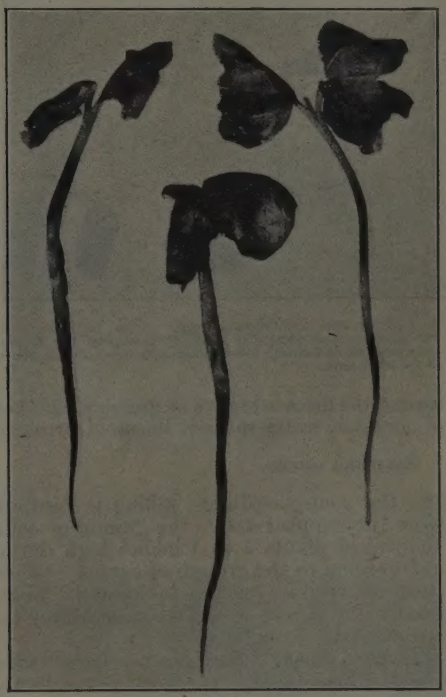

FIG. 5.—Cotton seedlings attacked by anthracnose on the darkened areas of the stems.

After penetrating the wall of the growing boll the fungus develops readily in the immature lint, finally penetrates the seed coats, and the disease may thus be carried over winter in the seed. The presence of the fungus in the seed was demonstrated by the writer in unpublished experiments made in 1905, when seed secured from anthracnose-diseased bolls were sterilized externally and then germinated in sterile Petri dishes. The fungus grew out of the seed and attacked and killed the seedlings, as shown in figure 4. More recently Barre has secured similar results from the germination of diseased seed and has also found the fungous filaments in the interior of the seed by means of paraffin sections.

Anthracnose-affected cotton bolls are so generally inhabited by insects, particularly by a small brown bug (*Carpophilus dimidatus*), that many farmers believe them to be the cause of the disease. They have no causal connection with the trouble, but merely find the decaying boll an excellent feeding and breeding place.

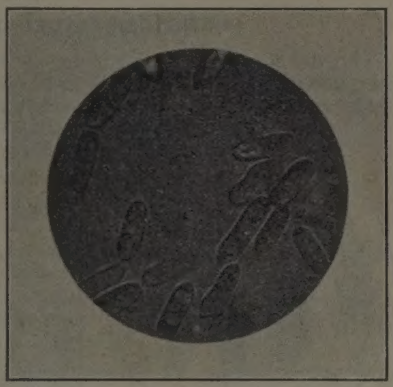

FIG. 6.—Conidia of *Glomerella gossypii* from a pure culture on beef agar. (Magnification, 625 diameters.)

VITALITY OF THE FUNGUS.

It has been proved by Barre that the anthracnose fungus may live on diseased bolls in the soil for 12 months, but in no case has it been known to live longer under field conditions. This has an important bearing on methods of control, as it would appear that a 1-year rotation would be sufficient to free an infected field from the disease.

In the seed, however, the fungus has been known to live as long as three years, and the disease is thus carried from year to year and from place to place. This fact emphasizes the importance of selecting seed for planting which is free from disease.

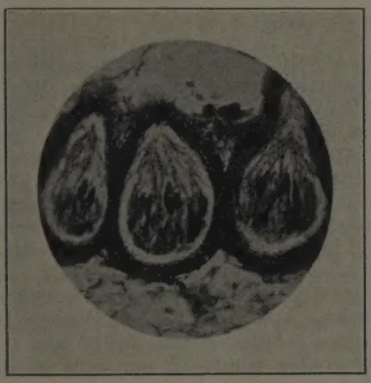

FIG. 7.—Perithecia of *Glomerella gossypii*, photographed from type slide. (Magnification, 200 diameters.)

MEANS OF DISSEMINATION.

Anthracnose is spread by means of the fungous mycelium and spores in and on the seed and on bits of diseased bolls or stems left in the field in the fall. The pink spores first formed on the bolls are produced in sticky masses, which on drying adhere to the diseased areas, and in this condition can not readily be blown about by the wind. During rainy weather, however, these spore masses soften up and the spores are scattered about by the wind and raindrops.

Insects are also doubtless active agents in carrying the spores from plant to plant, as the sticky masses readily adhere to their feet and mouth parts. In an experimental way Barre has obtained more than 40 per cent of infections from spraying the spores into open flowers. This means of transmission may readily be effected by bees and other insects feeding alternately on the sticky spore masses and on the flower honey.

Anthracnose is also spread at the cotton gin. Spores of the fungus are left in the machine by badly diseased lots of cotton, and these adhere to the seed of the next lot ginned. Seed for planting, which is otherwise free from disease, may thus be thoroughly infected.

CONDITIONS FAVORING ANTHRACNOSE.

The development of anthracnose on cotton is dependent on the presence of the causal fungus in or on the seed planted or in the soil. Cold, wet weather a few days after planting furnishes conditions unfavorable to the cotton seedlings and favorable to this fungus. During such periods many badly infected seeds have their sprouts killed even before they have come up, as shown in figure 4, and plants 2 to 3 inches tall are attacked and killed by the anthracnose fungus. On the bolls and stems anthracnose thrives during warm, rainy periods or in fields where a rank growth of cotton from too high fertilization or too close planting furnishes shade and moisture. Bolls that come in contact with the soil are also more liable to injury for the same reason. The disease will sometimes occur when some of these conditions are absent, but in such cases a severe infection or a very susceptible variety is responsible for serious injury.

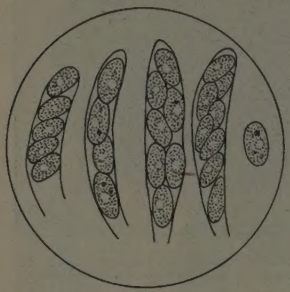

FIG. 8.—Asci and ascospores of *Glomerella gossypii*. (After Edgerton.)

EXTENT OF LOSS.

Loss from anthracnose is due to (1) the killing of cotton seedlings, resulting in a broken stand; (2) the entire destruction of bolls; (3) the partial destruction of bolls and discoloration of the remaining lint, causing a reduction of grade; and (4) the injury to stems and boll pedicels. The financial loss from the disease is difficult to estimate, as its occurrence and severity vary in different localities. Occasionally the loss is as great as 80 to 90 per cent on individual farms, while on adjoining places little trouble is experienced. Losses varying from 5 to 20 or 30 per cent and in some cases 50 to 75 per cent of the crop have been reported from all sections of the cotton belt. As early as 1896 Atkinson noted the destruction of 10 to 50 per cent of the cotton crop on certain plantations in the vicinity of Brundidge, Ala., though this was the only place where serious injury was observed. Southworth reported two cases where 75 per cent of the crop was destroyed, but states that in general the loss is from 10 to 25 per cent. In 1910 the loss in South Carolina alone was estimated at $4,000,000. Careful estimates of losses on individual farms in that State made in 1911 by Barre showed that the disease destroyed from 10 to 60 per cent of the crop. These estimates were made on fields of 25 to 800 acres located in different sections of the State. On 20 other farms, comprising an area of 1,800 acres, the total loss was estimated at $10,000. A conservative estimate of the total annual loss for the State is placed at more than $1,000,000, or about 1¼ per cent of the crop. The average annual value of the cotton crop of the United

States for the five years 1907 to 1911, inclusive, was $803,460,000. Placing the annual loss from cotton anthracnose over the whole cotton belt at 1 per cent, a very conservative figure, the total money value of the crop destroyed by this disease would reach $8,034,600.

REMEDIAL MEASURES.

The results of experiments to date indicate that damage from anthracnose is very largely preventable. The methods available for the reduction of loss are (1) the selection of planting seed free from disease; (2) the rotation of crops, combined with fall plowing; and (3) the use of varieties least susceptible to the disease.

SEED SELECTION.

The careful selection of seed for uniformity of type and for qualities of high commercial value is rapidly becoming a fixed farm practice. If this selection is to be most effective it must include also the factor of resistance to or freedom from disease. In dealing with anthracnose, because of the fact that the fungus is carried in the seed it is of supreme importance that seed shall be saved for planting only from fields where the least possible disease is present and only from bolls which are entirely free from the trouble. It is also desirable to select for picking only such plants as show no signs of boll-rot. Only by observing these precautions can disease-free seed be obtained. Excellent results have been secured from seed selection, even where as high as 20 per cent of anthracnose was present in the field where the seed was selected. Cotton from such seed, planted on anthracnose-free land, gave no sign of disease, while unselected seed from the same field planted on the noninfected land produced a crop which had an abundance of boll-rot. When seed has been carefully selected for freedom from disease, every precaution must be taken to avoid reinfection. Gins to be used for such seed should be thoroughly cleaned before the selected cotton is ginned.

Care must also be exercised in buying seed to make sure that it is free from anthracnose infection. Seedsmen should pay greater attention to seed selection, so that this disease may not be spread in the seed they sell. It is now unlawful to bring seeds for planting into the State of South Carolina, or to ship them within the State if they are infected with anthracnose.

No form of seed treatment yet devised will free diseased seed from the fungus, since any chemical which will kill the fungus beneath the seed coats will also kill the seed.

CROP ROTATION.

Since it has been proved that the anthracnose fungus can survive in the field on diseased bolls for at least a year, rotation of crops is almost as important as seed selection as a means of reducing damage from this disease, while at the same time conforming with the best farm practice. The planting of cotton on land where anthracnose was prevalent the previous season should never be practiced, for in such fields the disease is sure to be materially increased. It has been found that the planting of infected land in other crops for but one year very largely reduces the amount of infection and makes

it possible to grow cotton successfully the following year. In cases where the disease has been very severe the burning of the stalks in the fall is advisable.

Fall plowing in connection with crop rotation has also been found helpful in freeing the land from disease infection. Furthermore, a considerable reduction in the amount of anthracnose has followed the growing of a winter cover crop on diseased fields between the cotton crops.

RESISTANT VARIETIES.

It is a well-known fact that cotton varieties differ markedly in their susceptibility to anthracnose injury, though no variety is entirely immune. However, since the factor of seed infection is always to be considered, it is not safe to judge from a single test whether marked freedom from anthracnose in a variety is due to inherent disease resistance or merely to absence of seed infection. Disease-free seed even from a very susceptible variety planted on noninfected land would produce a healthy crop unless it were infected from adjacent diseased cotton. Different tests have given varying data as to the susceptibility and resistance of varieties, owing to the lack of uniformity in seed, in soil infection, and in weather conditions. The best that can be done is to choose varieties which have shown the greatest disease resistance combined with other essential qualities and to avoid those most susceptible to disease.

Several variety tests that have been carried on agree in placing the Cook, Brown, and Blue Ribbon among the varieties most susceptible to anthracnose injury. The Columbia, Allen Long-Staple, Keenan, Hardin, Half-and-Half, and sometimes the Triumph, have also shown themselves more than ordinarily subject to injury from the disease. In other tests the Triumph has been fairly free from boll-rot. The same tests have placed the Toole, Poulnott, King, Dixie, and Dillon among those most free from anthracnose. Other varieties usually resistant to the disease are the Cleveland, Russell, Truitt, and Rowden, though these have been known to show considerable boll-rot.

SUMMARY.

Cotton anthracnose occurs throughout the cotton belt and causes an annual loss of several million dollars.

The disease attacks and kills seed and seedlings and causes a serious rot of the bolls.

Anthracnose is caused by the fungus *Glomerella gossypii*, which is propagated by spores carried in or on the seed and by insects.

The fungus can live on dead bolls in the field for at least a year and in the seed for two or three years.

Boll-rot is favored by warm, rainy weather and by too close planting.

Remedial measures consist of the selection of healthy seed for planting, the rotation of crops, and the use of varieties known to be resistant to anthracnose.

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